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Mattingly, Jr.

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[54] **REMOVAL TOOL AND METHOD OF USING**

[75] Inventor: **William R. Mattingly, Jr.**, Santa Ana, Calif.

[73] Assignee: **Matrix Science Corporation**, Torrance, Calif.

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[51] **Int. Cl.**[2] **H01R 43/00**

[52] **U.S. Cl.** ..... **29/629**; 29/235; 29/278; 29/427; 29/453; 29/764; 339/217 S

[58] **Field of Search** ..... 29/764, 629, 758, 426, 29/427, 278, 235, 453; 339/217 S

[56] **References Cited**

U.S. PATENT DOCUMENTS

3,110,093	11/1963	Johnson	29/764 X
3,541,661	11/1970	Nava	29/764 X
3,824,670	7/1974	Clark	29/758 X

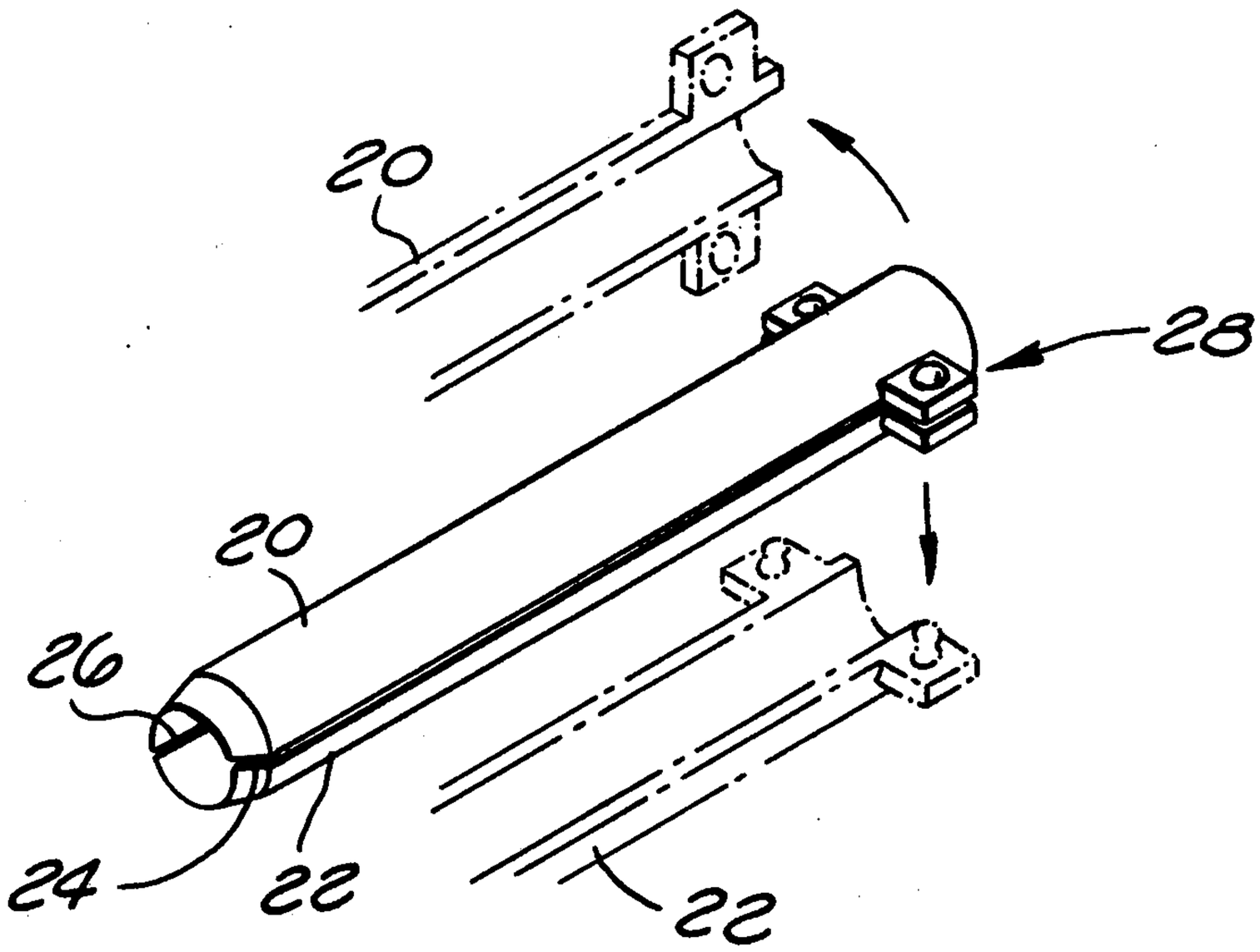
Primary Examiner—Carl E. Hall

Attorney, Agent, or Firm—Nilsson, Robbins, Dalgarn, Berliner, Carson & Wurst

[57] **ABSTRACT**

A removal tool having a tubular shape with a chamfered end and a method for utilizing the same in an electrical connector apparatus. The connector apparatus has a contact attached around and to the end of a wire. An elliptical rear edge of the contact has major axis edge portions which come in contact with an inside shoulder of an insulator body passageway preventing the contact from being removed rearwardly from the connector. The chamfered end of the removal tool is inserted between the wire and the inside elliptical surface to resiliently deform the ellipse to a circular or near circular shape so that it may be withdrawn through a rear passageway.

5 Claims, 4 Drawing Figures



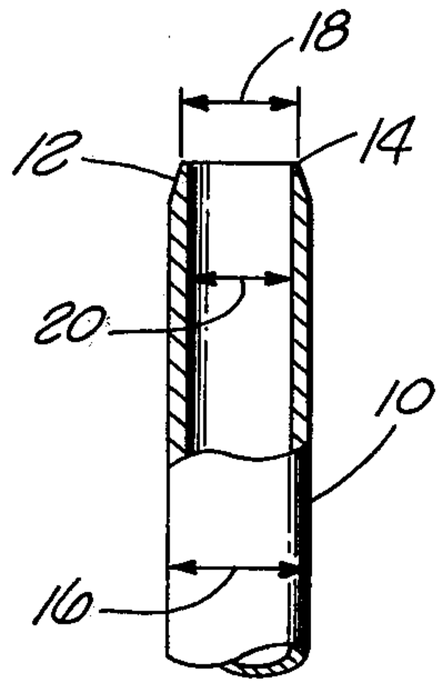


FIG. 1.

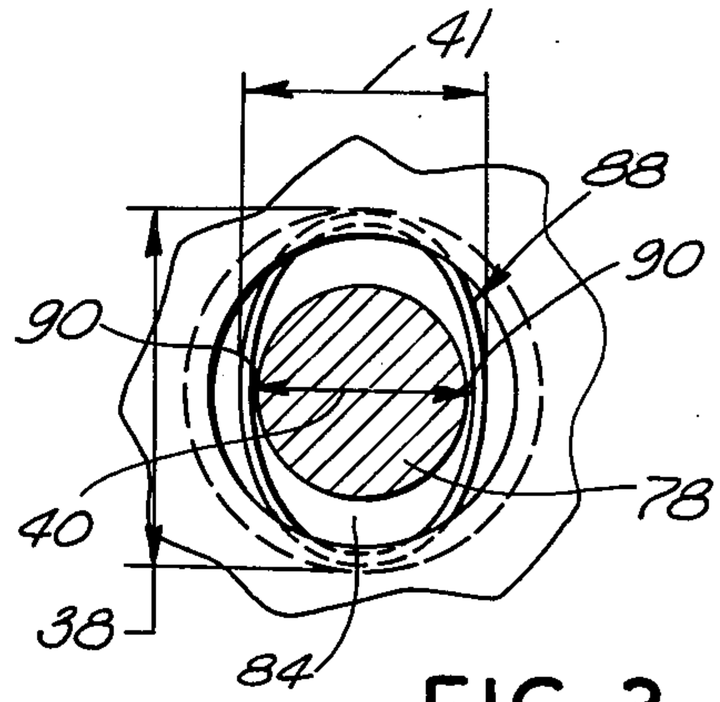


FIG. 3.

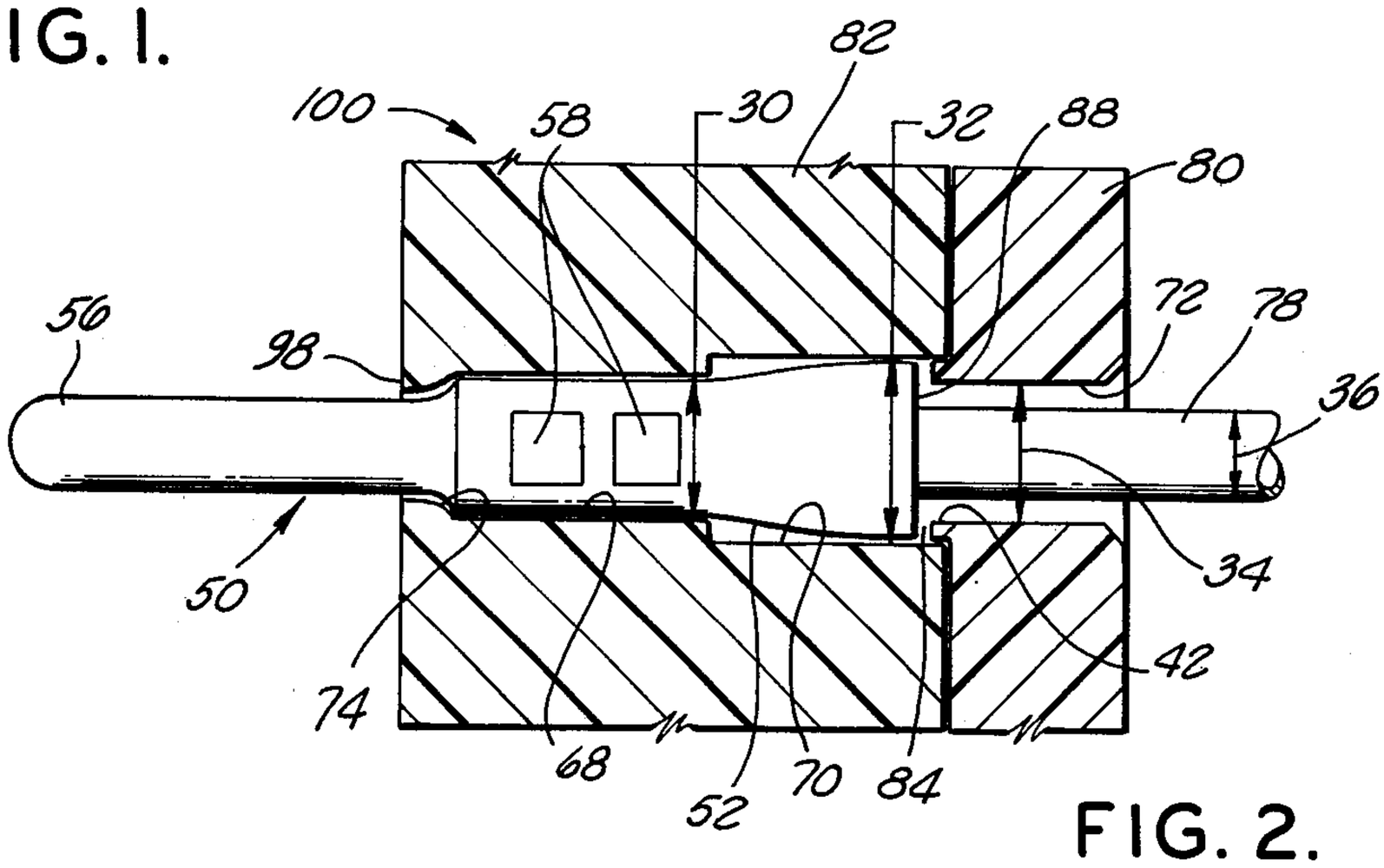


FIG. 2.

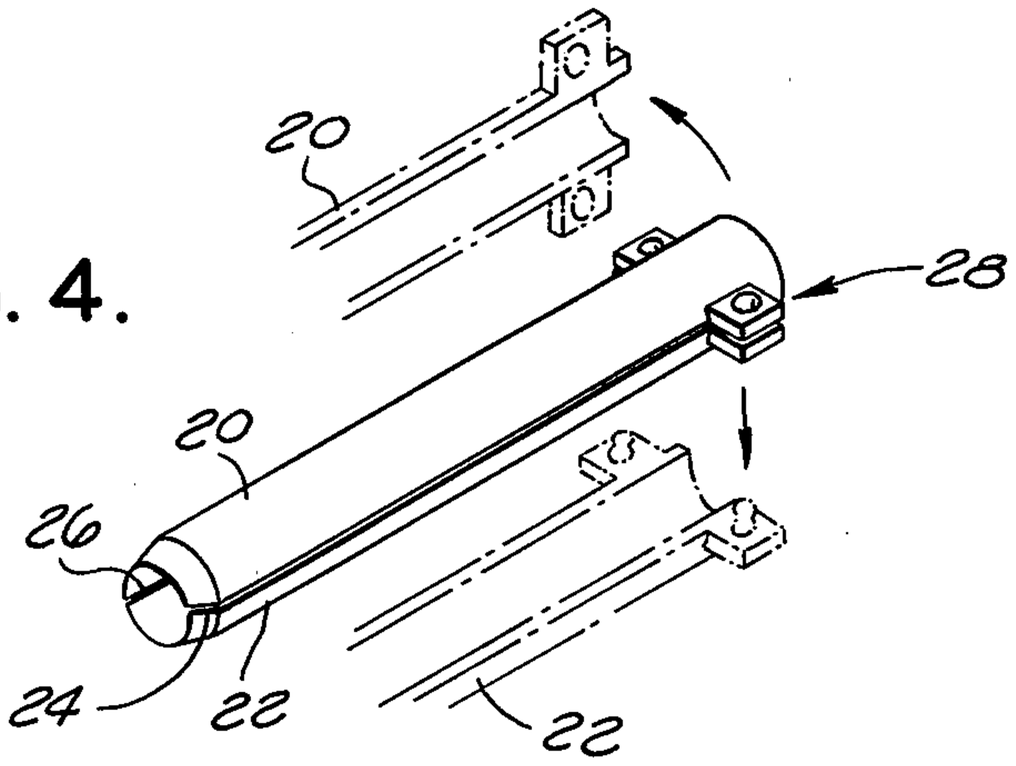


FIG. 4.

REMOVAL TOOL AND METHOD OF USING

BACKGROUND OF THE INVENTION

The present invention relates to electrical connectors and, in particular, to removal tools for removing a contact retained in an insulation body by an elliptical retaining edge in contact with a circular inside insulator shoulder.

Various prior-art connector designs have been disclosed in my co-pending U.S. Patent Application Ser. No. 923,236, filed July 10, 1978, which itself is for a novel connector system. In conjunction with all connectors and connector systems having a plurality of electrical contact portions and a retaining insulator portion, it is desirable that each electrical contact portion be easily removable from the retaining insulator portion without damaging or having to provide an entirely new retaining insulator portion. The present invention discloses such a removal tool that allows each individual contact portion to be removed from the insulator portion through the rear of the connector rather than through the front of the connector as would be required, for example, with the connector assembly disclosed in U.S. Pat. No. 3,396,364.

SUMMARY OF THE INVENTION

The present invention comprises a removal tool for removing a contact, circumferentially attached to the end of a wire, from an insulator passageway. The insulator passageway defines an interior cylindrical passageway having a first diameter and a connecting cylindrical passageway having a second diameter where the first diameter is larger than the second diameter. The contact is provided with a retaining end having an elliptical cross section where the minor inside diameter of the elliptical cross section is at least as large as the diameter of the wire. The major outside diameter of the elliptical cross section of the retaining end is greater than the second diameter so that the contact is retained in the interior cylindrical passageway. The removal tool for removing a contact of the above configuration comprises a tube having a chamfered end where the tube is adapted for being slidably positioned around the wire with the chamfered end positioned for being inserted into the elliptical retaining end of the contact. The outside diameter of the tube is greater than the minor inside diameter of the elliptical cross section of the retaining end of the contact and smaller than the second diameter of the connecting passageway.

In one embodiment, the removal tool may additionally have a single longitudinal slot along its length whereby the tube may be removably positioned around the wire.

In yet another embodiment, the removal tool may have two longitudinal slits along its length whereby the removal tool may be removably positioned around the wire.

In the preferred embodiment of the removal tool, the outside diameter of the leading edge of the chamfered end is preferably at least as small as the minor diameter of the elliptical cross section of the retaining end of the contact.

A novel method of removing a contact, circumferentially attached to the end of a wire, from an insulator passageway may thus be provided where the insulator passageway defines an interior cylindrical passageway having a first diameter and a connecting cylindrical passageway having a second diameter, where the first diameter is larger than the second diameter. The contact further has a retaining end with an elliptical cross section where the minor inside diameter of the elliptical cross section is at least as large as the diameter of the wire and the major outside diameter of the elliptical cross section is greater than the second diameter whereby the contact is retained in the interior cylindrical passageway. The method of removing the contact as described comprises the steps of providing a removal tool having a tubular shape—the removal tool having a chamfered end, positioning the removal tool around the wire, inserting the chamfered end of the removal took into the retaining end of the contact between the wire and the inside surface of the retaining end for resiliently increasing the minor diameter and decreasing the major diameter until the major diameter and the minor diameter are simultaneously smaller than the second diameter and, finally, withdrawing the removal tool of the contact and the attached wire from the insulator passageway through the connecting cylindrical passageway having the second diameter.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention will be better understood from the detailed description below taken in conjunction with the drawings wherein like reference characters refer to like parts throughout and in which:

FIG. **1** is a plan view of the removal tool in accordance with the present invention;

FIG. **2** is illustrative of a connector assembly having a contact which may be removed from an insulator portion by the removal tool of the present invention;

FIG. **3** is an end plan view as seen from the rear of the connector shown in FIG. **2**;

FIG. **4** is a pictorial plan view of one embodiment of the present invention showing a dual slit arrangement along the length of the removal tool.

DETAILED DESCRIPTION

Referring first to FIG. **1**, the removal tool of the present invention for utilization in removing the clipless contact disclosed in U.S. Pat. Application Ser. No. 923,263, filed July 10, 1978, comprises a cylindrical tube **10** having a beveled or chamfered end **12** and a leading edge **14** of the chamfered end **12**. As shown in FIG. **1**, the removal tool of the present invention has a generally circular inside passageway having an inside diameter **20** and a generally cylindrical outside surface having an outside diameter **16**. The minimum outside diameter **18** of the chamfered end **12** thus occurs at the leading edge **14** of the tube **10**. The removal tool shown in FIG. **1** is particularly useful in removing an electrical contact, such as a pin contact or a socket contact, from an insulator, a detailed description of which has been shown in my co-pending application Ser. No. 923,263. By way of illustration, a representative pin contact as positioned in place in a passageway through an insulator is shown in FIG. **2**.

Referring to FIG. **2**, a pin contact or member **50** having a pin portion **56** and an elliptical retaining portion **52** is shown in place in an insulator assembly **100** and comprises of a front pin insulator member **82** and a rear insulator member **80** which, when connected together, define a contact insertion passageway having a front passageway portion **68** with a front insulator passageway retaining shoulder **74** for preventing the

contact member **50** from passing through the front of the contact insulator assembly. The pin insert passageway also comprises a front insulator retaining passageway **70**. A rear insulator passageway portion **72** is provided through the rear insulator **80**. The rear insulator **80** has a circular lip **42** which extends into the central retaining passageway portion **70** to define a circular retaining shoulder **84**. A wire **78** is inserted into the pin contact **50** and is held in place by the crimps **58**.

The contact **50** and insulation assembly **100** are assembled by inserting the pin engagement region **56** through the rear insulator passageway **72**, the front insulator retaining passageway **70** and out through the front end **98** of the insulator assembly **100**. As the pin portion of the contact is inserted, the retaining portion **52** enters the rear insulator passageway portion **72**, the elliptical shape of the retaining portion **52** having a retaining edge **88**, is resiliently deformed by the surface of the rear passageway portion **72** to assume a more circular cross section. When the retaining edge **88** passes the circular retaining shoulder **84**, it again returns to an elliptical cross-sectional shape with the rear shoulder **84** preventing the contact **50** from thereafter being removed except with a removal tool.

Referring now to FIG. **3**, the end of the connector assembly as viewed through the rear insulator **80** in FIG. **2**, is shown illustrating the circular cross section of the wire **78** and the elliptical cross section of the retaining edge **88** around the wire **78**. The elliptical cross section of the edge **88** is shown in position behind the circular retaining shoulder **84** which is perpendicular to and connects the front insulator retaining passageway **70** and the rear insulating passageway **72**.

In FIG. **2**, the relative dimensions of the various essential parts of the present invention are shown where the wire **78** has a wire diameter **36**, the rear insulator passageway **72** has a diameter **34** larger than wire diameter **36**, and the front insulator retaining passageway **70** has a diameter **32** which is larger than the rear insulator passageway diameter **34**. Although not essential in the preferred embodiment, the retaining portion of the contact which includes the region where the crimps **58** are located, as well as the region where the elliptical cross section retaining portion **52** is located, is made from the same cylindrical tube into which the wire **78** is inserted. Thus, the region of the retaining portion at which the wire **78** is crimped by the crimps **58** is generally circular, having a diameter of **30**.

Referring to FIG. **3**, the elliptical cross section retaining portion **52** may be formed by pinching the end of the retaining portion so that the end assumes a permanently elliptical shape which is resiliently deformable to a circular shape having a diameter **30**. Thus, as shown in FIG. **3**, the retaining edge **88** of the contact **50** is elliptically shaped with the major outside diameter of the ellipse **38** and a minor inside diameter **40**. In the preferred embodiment, the minor inside diameter **40** of the retaining edge **88** of the contact **50** is somewhat larger than the wire diameter **36** so that a small space **90** will exist on either one or both sides between the outside surface of the wire and the inside surface of the elliptically cross-sectioned retaining portion **52** at the retaining edge **88**. This small space **90** is preferable so that the leading edge **14** of the removal tool may be inserted between the inside surface of the retaining portion of the contact **50** and the outside surface of the wire.

In addition, it is preferable that the outside diameter of the tube **10** (FIG. **1**) comprising the removal tool, be such that when the removal tool is fully inserted into the rear portion of the contact **50** the elliptically cross-sectioned retaining portion **52** will be resiliently deformed so that the minor outside diameter and the major outside diameter will be approximately equal to the outside diameter **16** of the tube **10**. Simultaneously, the major outside diameter **38** of the retaining edge **88** of the elliptically cross-sectioned retaining portion **52** will be decreased to a diameter less than the inside diameter **34** of the rear insulator passageway **72**. Since the minor outside diameter **41** of the retaining edge **88** will also be less than the diameter **34** of the rear insulator passageway **72**, the removal tool and the contact **50** will no longer be retained by the circular retaining shoulder **84** and may consequently be removed through the rear insulator passageway **72**.

A significant advantage of the present invention is that, because the ellipitically cross-sectioned retaining portion **52** is resilient, when the removal tool is inserted into the interior of the elliptically cross-sectioned retaining portion **52**, the inside surface opposite the minor diameter will press firmly against the outside of the tube **10**, thus allowing the removal tool to be firmly held by the resiliently deformable, elliptically cross-sectioned retaining portion **52** so that the contact **50** will be withdrawn through the rear insulator passageway **72** at the same time that the removal tool is withdrawn therethrough. Of course, once the contact has been withdrawn from the insulator, the removal tool may be withdrawn from the space between the interior surface of the retaining portion and the outside surface of the wire **78** whereupon the retaining edge **88** will return to its elliptical shape.

In one embodiment of the present invention, the removal tool may be a tube such as the tube **10** in FIG. **1** which is unslit. A removal tool having this configuration may be permanently assembled to the wire **36** before crimping the contact onto the edge of the wire. Alternatively, the removal tool tube **10** may be slit along one side. By making the tube out of a resilient material, such as a soft plastic, the interior of the tube **10** may be exposed by separating the tube along the slit and then inserting the wire through the slit. The removal tool may then be slid along the wire for being inserted into the interior of the contact.

In still another embodiment, such as that shown in FIG. **4**, the removal tool may be split along two sides by a first slit **24** and a second slit **26**. The removal tool then comprises a first tube half **20** and a second tube half **22** which may be coupled together by a snap or hinge connection **28** or any other suitable connection whereby the two halves **20** and **22** of the removal tool may be fitted around the wire and snapped in place. The removal tool may then be utilized in the manner previously described.

Of course, it will be appreciated that any number of slits may be provided in the removal tool but it will obviously be preferable to have no more than two oppositely positioned slits, such as that shown in FIG. **4**.

In summary, therefore, the removal tool comprises a cylindrical, chamfered tube, which may be slit longitudinally. The removal tool is positioned around a wire to which a contact **50** is crimped by the crimps **58**. The contact may be removed from the insulator by pushing the chamfered end of the removal tool along the wire to make entry into the insulator passageway of the connector. As the leading edge **14** of the removal tool enters the interior retaining passageway **70**, the minor diame-

ter of the elliptical retaining portion of the contact is increased by sliding up the chamfer of the removal tool until the retaining edge **88** of the contact **50** is circular or near circular in cross section. At this point, the wire and removal tool may be withdrawn with the contact **50** from the insulator passageway.

Although various specific details of the present invention have been illustrated, all such details and specifics are illustrative only and are not to be construed in a limiting sense.

I claim:

1. A removal tool for removing a contact, circumferentially attached to the end of a wire, from an insulator passageway defining an interior cylindrical passageway having a first diameter and a connecting cylindrical passageway having a second diameter, where the first diameter is larger than the second diameter, the contact having a retaining end with an elliptical cross section where the minor inside diameter of the elliptical cross section is at least as large as the diameter of the wire and the major outside diameter of the elliptical cross section is greater than the second diameter for retaining the contact in the interior cylindrical passageway, the removal tool comprising:

a tube having a chamfered end for being slidably positioned around the wire with the chamfered end positioned adjacent the retaining end of the contact for being inserted between the wire and the minor inside diameter of the retaining end of the contact, the outside diameter of the tube being greater than the minor inside diameter of the elliptical cross section of the retaining end of the contact and smaller than the second diameter.

2. The removal tool of claim **1**, the tube having a single longitudinal slit along its length whereby the tube may be removably positioned around the wire.

3. The removal tool of claim **1**, the tube having at least two longitudinal slits along its length whereby the tube may be removably positioned around the wire.

4. A removal tool for removing a contact, circumferentially attached to the end of a wire, from an insulator passageway defining an interior cylindrical passageway having a first diameter and a connecting cylindrical passageway having a second diameter, where the first diameter is larger than the second diameter, the contact having a retaining end with an elliptical cross section where the minor inside diameter of the elliptical cross section is at least as large as the diameter of the wire and the major outside diameter of the elliptical cross section is greater than the second diameter for retaining the contact in the interior cylindrical passageway, the removal tool comprising;

a tube having a chamfered end for being positioned around the wire with the chamfered end positioned adjacent the retaining end of the contact for being inserted between the wire and the minor inside diameter of the elliptical cross section of the retaining end of the contact for resiliently increasing the minor diameter and decreasing the major diameter until the major diameter and the minor diameter are simultaneously smaller than the second diameter.

5. A method for removing a contact, circumferentially attached to the end of a wire, from an insulator passageway defining an interior cylindrical passageway having a first diameter and a connecting cylindrical passageway having a second diameter, where the first diameter is larger than the second diameter, the contact having a retaining end with an elliptical cross section, the method comprising the steps of:

providing a removal tool having a tubular shape, the removal tool having a chamfered end;

positioning the removal tool around the wire;

inserting the chamfered end of the removal tool into the retaining end of the contact between the wire and the inside surface of the retaining end for resiliently increasing the minor diameter and decreasing the major diameter until the major diameter and the minor diameter are simultaneously smaller than the second diameter; and

withdrawing the removal tool, the contact and the attached wire from the insulator cavity through the connecting cylindrical cavity.

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